Space Weather Technical Forecast

Issued on Thursday, 19 October 2023 at 13:01 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Weak CME arrivals possible, with a Slight Chance of isolated G1/Minor Geomagnetic Storm intervals throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity recorded at GOES16 and 18 has been notably Low over the past 24 hours, with the X-ray background well into B-class. Peak activity was confined to low C-class flares, with limited highlights being a long-period C1.2 around 19/0330UTC from the off-going northwest limb, and a more impulsive peak C1.5 from a newly-emerging region near the southwestern limb at 19/0152UTC.

There are currently three numbered regions on the visible disc and two unnumbered regions, all of which are relatively small and simple, and either stable or in decline.

Two main Coronal Mass Ejections (CMEs) were noted on imagery, apparently heading to the northwest and bookending the 24-hour period. Both of these events were analysed as far-sided to no effect at Earth.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE and DSCOVR at L1 showed influence from a modest positive polarity coronal hole fast wind, probably that from overdue CH60/+. The phi angle was accordingly positive (away from the Sun) throughout. In addition to this, there is possibly some contamination from either or both of the outstanding 14 October glancing CMEs, which had been due into the very start of the 24-hour period. While not conclusively present, these CMEs are now likely to have passed 1AU and are dropped from further mention in the forecast.

The solar wind speed rose to peak at Slightly Elevated levels and 450km/s around 18/1600UTC, gradually waning to a more typical background and 375 to end the period. The solar wind density trend was less clear, in part because of switching between the L1 measuring satellites introduced artificial seams and discontinuities. The trend was not far removed from a typical range in single figures ppcc overall. The IMF was highest to start the 24 hours, peaking at 13nT, while the north-south component was mainly anti-aligned with Earth's field in its range between -11nT and +6.

The net effect of the above solar wind measures was provisionally Quiet to Unsettled geomagnetic activity, peaking at Kp '3o' in the 03-06UTC interval.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at Background.

GOES16 high energy (greater than 2MeV) electron flux was at Normal Background throughout. Associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold. The observation at 19/0001UTC was 1.65e6 integrated pfu.

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Four-Day Space Weather Forecast Summary

Solar Activity: Low to Very Low activity is Expected. There is a Slight, but perhaps increasing Chance of isolated M-class X-ray flares through the period with any development that occurs on the disc, as is being seen narrowly over the western limb.

Solar Wind / Geomagnetic Activity: The geomagnetic forecast is best summarised as being complex and carrying high uncertainty, but of overall relatively low magnitude. There is a significant overlap in inbound CME arrival times (evidenced by the MOSWOC Enlil ensemble spread, which is at times antiphase), and determining individual events as having passed is not likely to be possible.

There are three remaining possibly inbound CMEs. Firstly, the C7.5 flare CME on 16 October carries a most likely arrival within the coming 24 hours. Secondly, a CME associated with a filament eruption on 17 October may arrive in the 24 hours following. Thirdly and finally, a CME from an eruption on 18 October might follow this event by a further 24 hours. All three therefore have most likely arrival times straddling adjacent UTC days.

Otherwise, current fast winds from CH60/+ are expected to soon ease, but with a potential weak enhancement possible from CH62/- fast winds from the end of the current UTC working week onward, however this is also very low confidence.

All considered, there is a Chance for spells of Unsettled to Active with any of the CME arrivals, with a Slight Chance of G1/Minor Storm intervals.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to persist at Background levels.

High energy electron flux (greater than 2MeV) is expected to be at Normal Background, perhaps rising to Moderate depending on the strength of any CME-sourced enhancement that occurs. The associated 24-hour electron fluence is expected to remain below Active (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 19/0630UTC.

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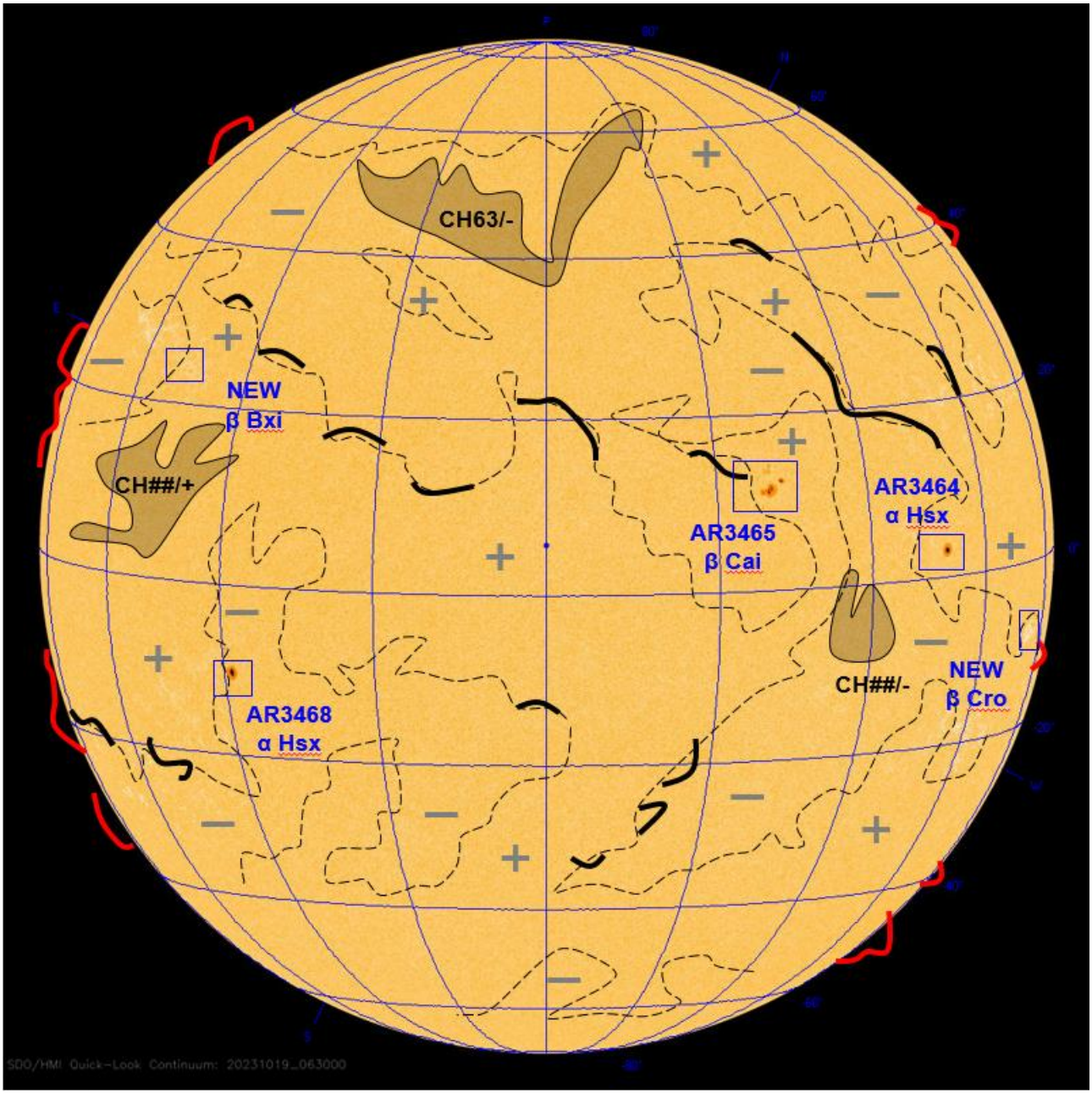
Met Office Space Weather Technical Forecast



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The geomagnetic forecast is best summarised as being complex and carrying high uncertainty, but of overall relatively low magnitude. There is a significant overlap in inbound CME arrival times (evidenced by the MOSWOC Enlil ensemble spread, which is at times antiphase), and determining individual events as having passed is not likely to be possible.

There are three remaining possibly inbound CMEs.

Firstly, the main potential for enhancement is now from the CME which left the northeast disc on 16 October, associated with the C7.5 from AR3467. The bulk of the material is modelled to miss, passing behind Earth, but with the chance of a slight glance either late day 1 or early day 2 (Thursday 19 into Friday 20 October).

Secondly, a CME was also observed from a filament eruption near Ex-AR3463 off the southwest disc early on 17 October. This is also expected to largely miss, passing ahead and south of Earth, but with the potential for a glancing impact either late day 2 or early day 3 (Friday 20 into Saturday 21 October).

Thirdly and finally regarding CMEs, a further eruption was observed from the southeast around 18/0530UTC. Tthis has been assessed as passing to the south and behind Earth late day 3 or early day 4 (Saturday 21 into Sunday 22 October), also with a slight chance of glancing impacts.
The coronal hole forecast comprises exit from the current CH60/+ and then a further low confidence enhancement from the small coronal hole 62/-. This may also increase winds to around 400km/s, with MOSWOC Enlil showing the arrival of a CIR region alongside either CMEs' glances on day 2. This feature is currently considered unlikely to impact on the forecast however, with the coronal hole much-reduced compared to the previous 27-day solar rotation, when very little enhancement was observed.

Overall, mainly Quiet geomagnetic activity is expected with Unsettled intervals. There is a chance for spells of Unsettled to Active with any of the CME arrivals, with a Slight Chance of G1/Minor Storm intervals.

Geo-Magnetic Storm	**Level**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Minor or Moderate	**G1 to G2**	No	10	15	5	5
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/1730	Partial	C7.5 AR3467	NE	680	20/0100 UTC	Low confidence Glancing impact
17/1430	Partial	Filament	SW	480	Late 20/Early 21 Oct. (Likely missing)	Very low confidence Glancing impact
18/1132	Partial	Filament	SE	610	Late 21/Early 22 Oct (Likely missing)	Very low confidence Glancing impact

Figure 2: Latest MOSWOC Enlil run, showing boxed magneta a series of up to three potentially inbound CMEs that left the Sun between 16 and 18 October. Of these, the first is likely to be the most impactful – should it arrive – with this due to cross 1AU later in the current UTC day or into Friday 20 October. Note that the solar wind speed and density are relatively unperturbed throughout, indicating the expected low magnitude of these enhancements.

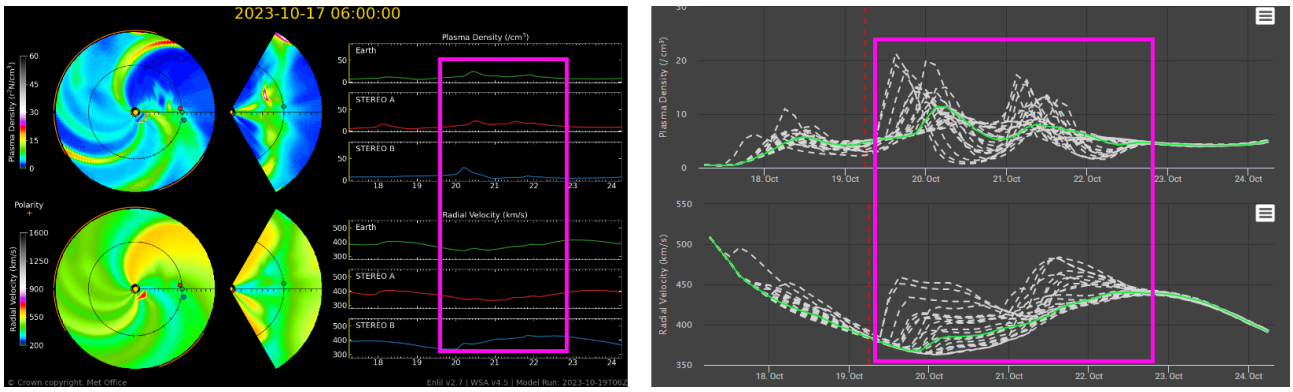

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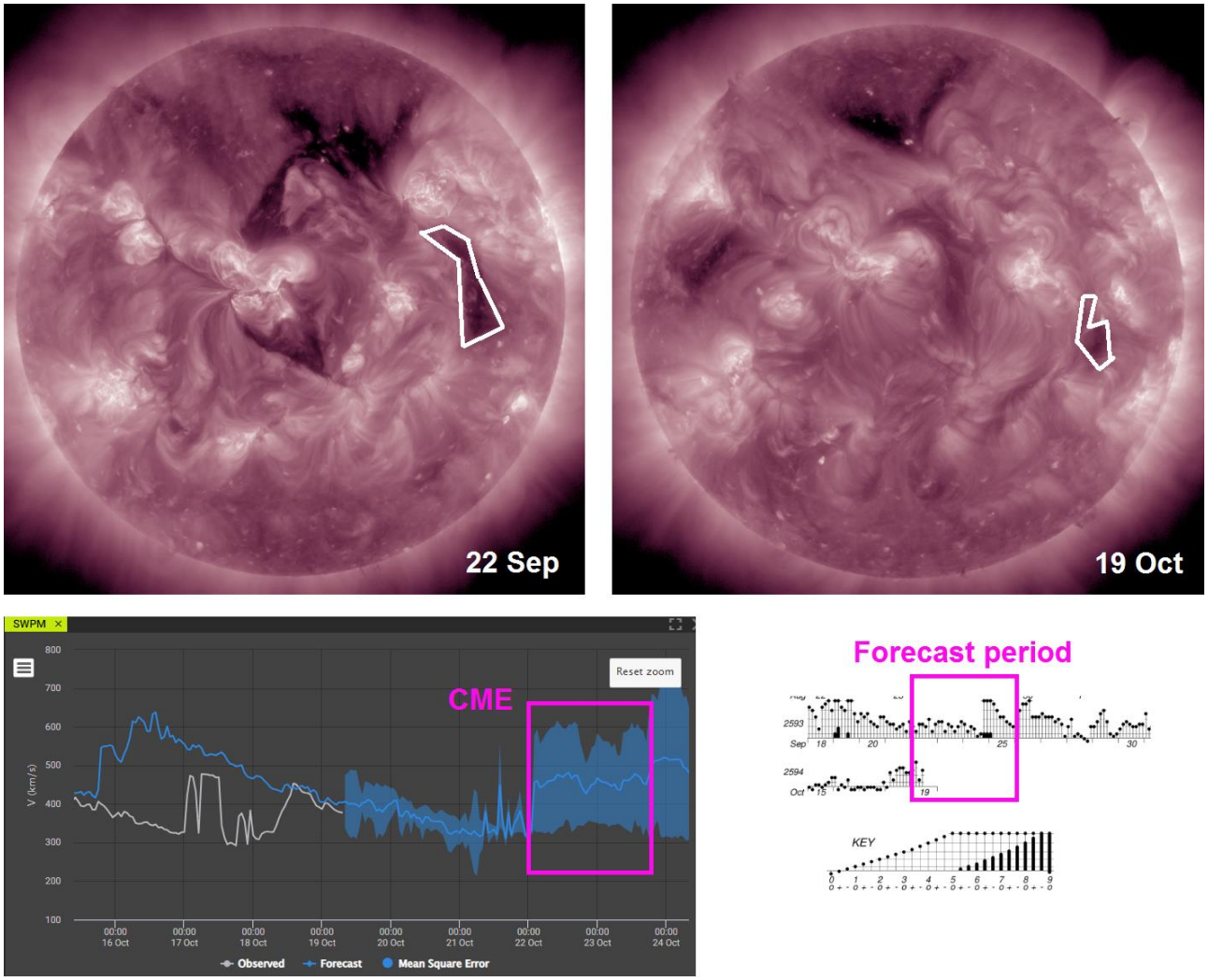
Figure 3: Clockwise from top left: comparison of previous and current rotations in AIA211, geomagnetic activity and solar wind speed. Note the presence of a CME on last pass.



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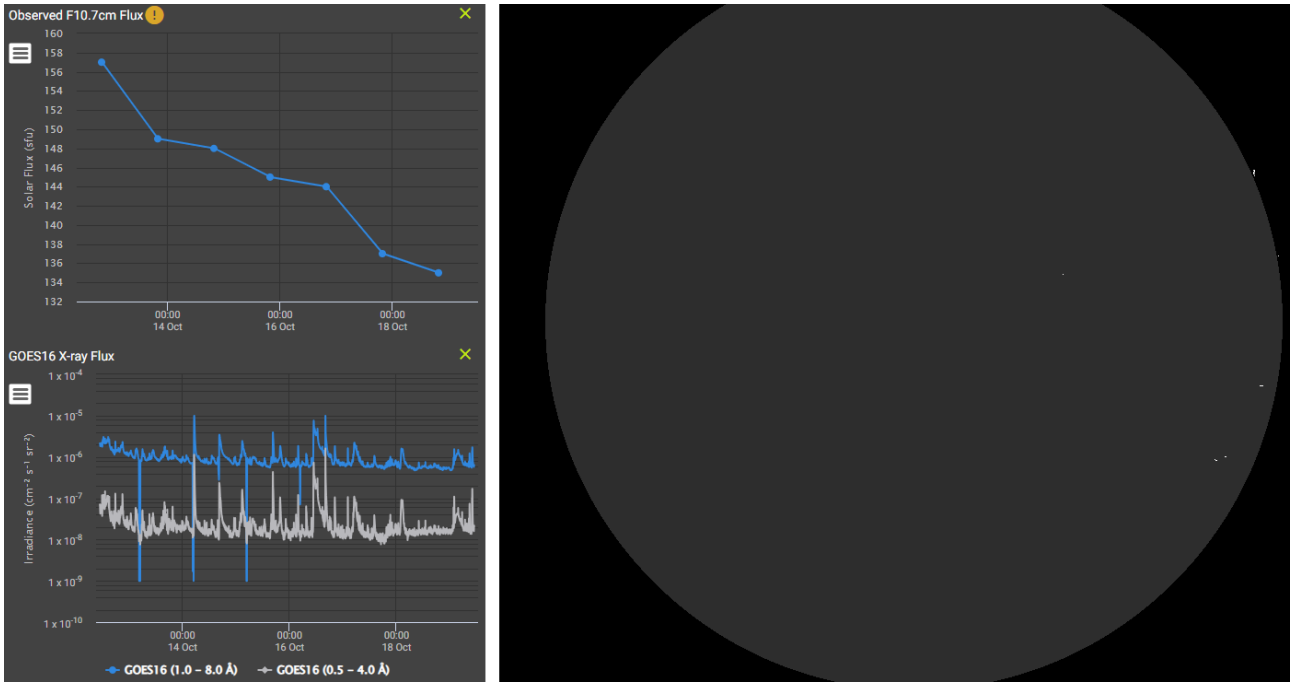
Radio Blackouts - X-Ray Flares:

Activity is expected to remain Low to Very Low, with only isolated C-class flares likely. There are currently three numbered regions on the visible disc and two unnumbered regions. All the spots on the visible disc are small and simple. There is only a Slight Chance of M-class flares, which perhaps rises slightly as the period evolves due to the uncharacteristically low starting point (for this stage of the cycle).

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	10	10	15	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 4: Clockwise from top left: Past week in Penticton 10.7cm flux, showing decline in sunspot activity over the past seven days; SIDC ROB-derived X-ray flares of C-class and above from PROBA2, showing few flares even registering, and those that have lying near the offgoing western limb; GOES16 X-ray flux, showing a declining intensity and cadence of significant flares.



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at Background levels, although given the intensifying activity narrowly over the western solar horizon, the initial risk has been raised very slightly before these regions rotate further from a potentially geoeffective position over the UTC weekend.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

Electron flux observed by GOES16 at GEO is currently at Normal Background levels. Solar wind enhancements are possible through the coming days, mainly associated with a number of potential CME arrivals throughout the period, or the onset of a HSS from the small coronal hole CH62/- fast wind. These are all low confidence however, and any enhancement is expected to be largely weak. These may increase electron populations in the Van Allen belts at times, which could bring periods of Moderate flux, most likely towards the end of the period.

The associated 24-hour fluence is expected to remain below the Active threshold, although an increasing trend is likely, especially towards the end of the period, depending on the strength of any enhancements that occur. This is supported by MOSWOC REFM, however this will only provide good guidance in the absence of any CME or fast wind enhancements.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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